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Pre-zoea Larva of *Petrocheles spinosus* Miers, 1876 (Crustacea, Decapoda, Anomura)

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Abstract

THE pre-zoea larval stage of *Petrocheles spinosus* Miers, 1876, is described from New Zealand. Ecdysis from the pre-zoeal stage to the first stage zoea larva is recorded in detail from laboratory observations.

INTRODUCTION

FIVE zoeal stages and one megalopa larval stage of *P. spinosus* have been described previously (Wear, 1965a). The zoea larvae were obtained from the Wellington Harbour plankton, and assigned to *P. spinosus* after the megalopa larva had been reared in the laboratory and subsequently compared with the first juvenile crab stage of this species described by Bennett (1932).

On 25 October 1965 a single ovigerous female was obtained from Halfmoon Bay, Stewart Island*, and was brought alive to Wellington where the eggs hatched on 1 November 1965. Pre-zoea larvae were thus obtained and the first stage zoea larvae reared from these were identical to those obtained from the Wellington plankton. This confirms the earlier identification and completes the life-history of *P. spinosus*.

MATERIALS AND METHODS

Drawings and descriptions of the pre-zoea larva, and of the sequence of ecdysis to the first zoeal stage, are based on recordings from 40 larvae observed individually from the time of hatching. The sea-water temperature remained constant between 15°C and 16°C.

Nomenclature of larval limbs and limb-segments is based on that of the previous paper (Wear, 1965a) except that the suffix " ite " is here deleted from limb-segment terminology. The colour code used in diagrammatic representation of chromatophores is given in Wear (1964).

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Incubation of Eggs

The parent crab (carapace length 11.5mm, width 12.0mm) carried 683 eggs within seven days of hatching. At this stage the eggs are ovoid in shape, measuring 0.69mm × 0.56mm, and the yolk is coloured bright orange. The embryo is transparent and without chromatophores, but eyespots are clearly visible. Two days from hatching eggs increased in size to 0.73mm × 0.60mm, with larval chromatophores visible, especially in the telson which is coloured bright red. Remaining yolk is orange. Eggs about to hatch (Fig. 1) measure 0.78mm × 0.63mm.

After the eggs hatched ovaries of the female crab were found to be gravid with bright orange immature eggs measuring 0.50mm × 0.45mm.

Pre-zoea Larva

The pre-zoea larva of *P. spinosus* (Fig. 2) is completely enveloped in a delicate cuticle. From the time of hatching it swims actively and is strongly attracted towards light. The pre-zoeal stage lasts from 30 to 45 minutes under laboratory conditions (16°C).

Description of Pre-zoea Larva

Cephalothorax

Proximal half of rostrum invaginated beneath carapace to level of posterior margin of eye (Fig. 2). Distal half telescoped, lying beneath the thorax, but small marginal setae not easily visible. Carapace folded and wrinkled, especially posteriorly. Remaining yolk visible in live specimens as bright orange pigmentation posterior to eye. Posterior carapace spines not invaginated but telescoped and procurved, and ventral spines found in zoea larvae (Wear, 1965a) not visible at this stage. Eyes large and sessile.

Cephalic Appendages

First antennae (antennules) (Fig. 3) unsegmented with surrounding pre-zoeal cuticle extended into one long lateral plumose process on inner margin and two long distal plumose processes. Outer distal margin with two small unarmed processes.

Second antennae (Fig. 4) two-segmented. Proximal protopod with a single unarmed process arising from its inner distal margin. Distal exopod with six long plumose processes along inner and distal margins, and a smaller unarmed process arising from tip on outer margin. Aciculate tip of exopod characterising stage one zoea larvae (Wear, 1965a) folded inside unarmed process.

Mandibles (Fig. 5) first maxillae (Fig. 6) and second maxillae (Fig. 7) as those of stage one zoea, but in the pre-zoea these appendages are surrounded by the pre-zoeal cuticle which is without spines or processes. First and second maxillae with spines of first zoea visible and protruding through cuticle.

Thoracic Appendages

First, second and third maxillipeds are developed (Fig. 2). The maxillipeds are non-functional, have no natatory setae, and the covering pre-zoeal cuticle is without spines or processes.

First maxillipeds (Fig. 2) biramous, consisting of short coxopod, longer basipod and unjointed exopod. Endopod four-segmented, half the length of exopod. Four terminal setae visible beneath cuticle of exopod, but do not protrude.

Second maxillipeds (Fig. 2) similar to the first, but with smaller, unjointed endopod.

Third maxillipeds (Fig. 2) uniramous and without setae as in the first stage zoea larvae (Wear, 1965a).

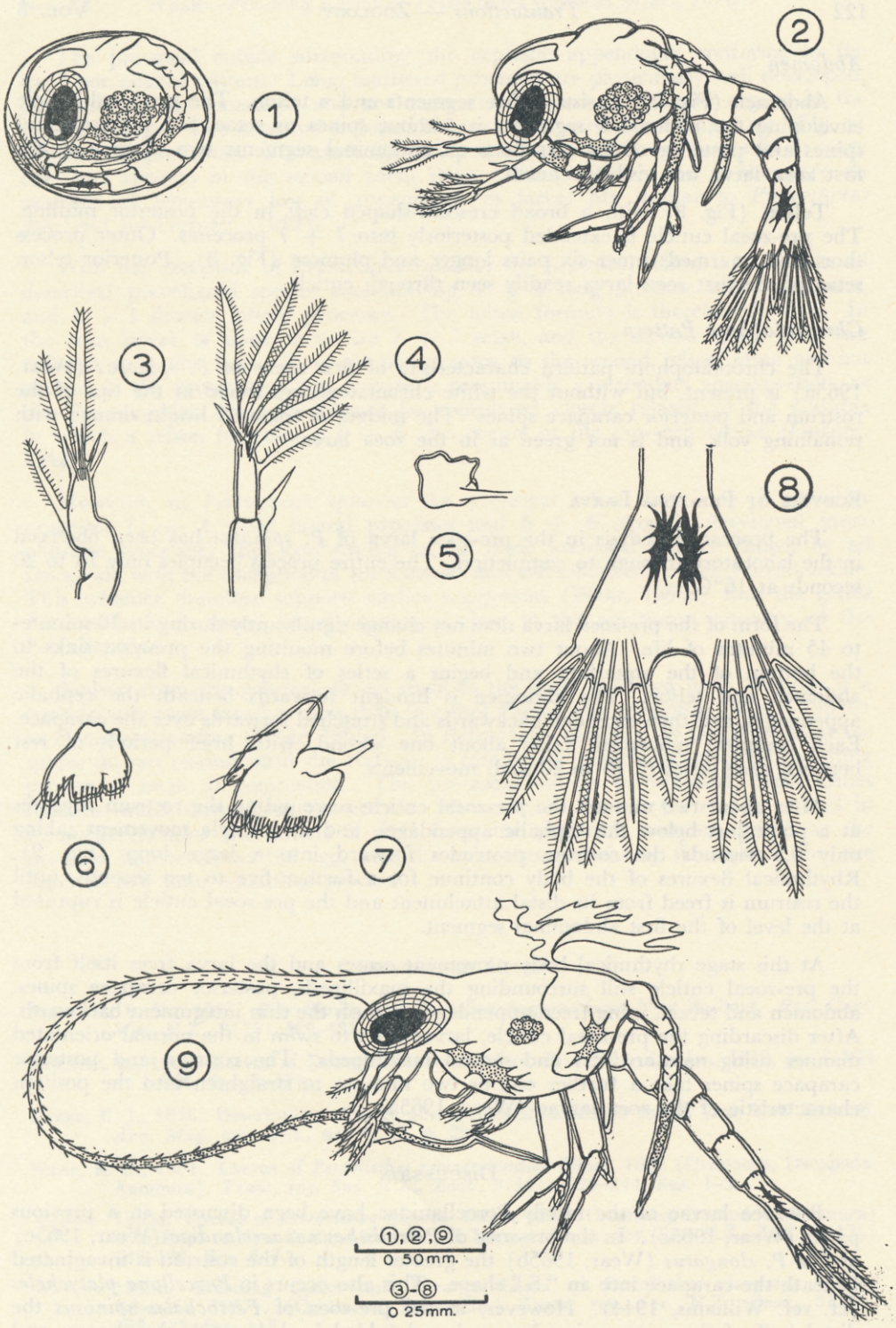

FIG. 1.—Mature egg about to hatch. FIG. 2.—Pre-zoea larva, lateral view. FIG. 3.—First antenna of left hand side, ventral view. FIG. 4.—Second antenna of left hand side, dorsal view. FIG. 5.—Mandible of left hand side. FIG. 6.—First maxilla of left hand side. FIG. 7.—Second maxilla of left hand side. FIG. 8.—Telson, dorsal view. FIG. 9.—Pre-zoea larva about to moult to first zoea, showing rostrum extended anteriorly into large loop.

Abdomen

Abdomen (Fig. 2) consists of five segments and a telson. The pre-zoeal cuticle enveloping the abdominal segments is without spines or setae, but posterolateral spines and posterior dorsal serrations on abdominal segments two to four of the first zoea larva are visible beneath.

Telson (Fig. 8) with a broad crescent-shaped cleft in the posterior midline. The pre-zoeal cuticle is extended posteriorly into 7 + 7 processes. Outer process short and unarmed; inner six pairs longer and plumose (Fig. 8). Posterior telson setae of the first zoea larva readily seen through cuticle.

Chromatophore Pattern

The chromatophore pattern characteristic of first zoeae of *P. spinosus* (Wear, 1965a) is present, but without the white chromatophores found at the tips of the rostrum and posterior carapace spines. The midgut is coloured bright orange with remaining yolk, and is not green as in the zoea larvae.

Ecdysis of Pre-zoea Larva

The process of ecdysis in the pre-zoea larva of *P. spinosus* has been observed in the laboratory through to completion. The entire process occupies only 15 to 20 seconds at 16°C.

The form of the pre-zoea larva does not change significantly during its 30 minutes to 45 minutes of life. About two minutes before moulting the pre-zoea sinks to the bottom of the aquarium and begins a series of rhythmical flexures of the abdomen and telson. The abdomen is brought forwards beneath the cephalic appendages, and then extended backwards and stretched forwards over the carapace. Each complete movement takes about one second, with brief periods of rest between each series of 15 to 20 such movements.

After about two minutes the pre-zoeal cuticle surrounding the rostrum ruptures at a point just below the cephalic appendages, and in a single movement taking only 0.5 seconds the rostrum protrudes forward into a large loop (Fig. 9). Rhythmical flexures of the body continue for a further five to ten seconds, until the rostrum is freed from its distal attachment and the pre-zoeal cuticle is ruptured at the level of the first abdominal segment.

At this stage rhythmical body movement ceases and the larva frees itself from the pre-zoeal cuticle still surrounding the maxillipeds, posterior carapace spines, abdomen and telson, using freed appendages to push the thin integument backwards. After discarding the pre-zoeal cuticle, larvae start to swim in the normal orientated manner using natatory first and second maxillipeds. The rostrum and posterior carapace spines take a further one or two minutes to straighten into the position characteristic of the zoea larvae (Wear, 1965a).

Discussion

Pre-zoea larvae of the family Porcellanidae have been discussed in a previous paper (Wear, 1965c). In the pre-zoea of *Petrolisthes novaezelandiae* (Wear, 1965c) and of *P. elongatus* (Wear, 1965b) the greater length of the rostrum is invaginated beneath the carapace into an " S " shape. This also occurs in *Porcellana platycheles* (cf. ref. Williams, 1944). However, in the pre-zoea of *Petrocheles spinosus* the distal half of the rostrum is telescoped and folded back beneath the thorax, and its proximal section is invaginated beneath the carapace as a straight tube extending back only to the posterior margin of the eye.

The pre-zoeal cuticle surrounding the cephalic appendages conforms to the basic porcellanid pattern. Long, feathered processes are particularly well developed, especially on the antennae, and are quite clearly used as natatory organs in the pre-zoeal stage. The antennal endopod is here represented as an empty sac (Fig. 4) without fringing setae. The antennal endopod of the zoea larvae is absent in stage one, but appears in the second zoeal stage (Wear, 1965a) and is therefore an example of temporary loss of appendages in larval life similar to *Pinnotheres* discussed by Gurney (1942).

With the exception of *Petrocheles spinosus* the pre-zoeal telson is similar in all described porcellanid species each having 5 + 5 long plumose inner processes, and 1 + 1 shorter lateral processes. The telson formula is therefore 6 + 6. In the zoea larvae of these there are 7 + 7 setae, and the second telson setae are reduced to a fine hair. Processes homologous to the second telson setae are not present in the pre-zoeae. This feature is presumably a secondary specialisation, as the Porcellanidae obviously cannot be considered closely related to the Caridea in which a telson formula of 6 + 6 also occurs in the pre-zoea larvae (Gurney, 1942).

However, in *Petrocheles spinosus* the pre-zoeal telson has 7 + 7 posterior processes (1 + 1 short lateral processes and 6 + 6 strongly developed inner plumose processes) thus conforming to the basic pre-zoeal pattern shown by all Decapoda with the exception of the Caridea and the remainder of the Porcellanidae. This evidence therefore supports earlier suggestions (Wear, 1965a) that the genus *Petrocheles* is in many larval characters close to the anomuran ancestry of the Porcellanidae.

Ecdysis from the pre-zoea larval stage to the stage one zoea in *P. spinosus* is a considerably more rapid process than in either *Petrolisthes elongatus* (Wear, 1965b) or *P. novaezelandiae* (Wear, 1965c). In *Petrocheles spinosus* the posterior carapace spines do not extend until the rostrum is completely evaginated and the moulting process is near to completion. The pre-zoeal cuticle surrounding these spines remains intact throughout the ecdysis. However, in *Petrolisthes elongatus* and in *P. novaezelandiae* the cuticle is shed from the posterior carapace spines as the pre-zoea hatches from the egg, and the spines extend slowly throughout the one hour to five hour moulting process.

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